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Threshold photoelectron and electron-ion coincidence spectroscopies: Past, present and future

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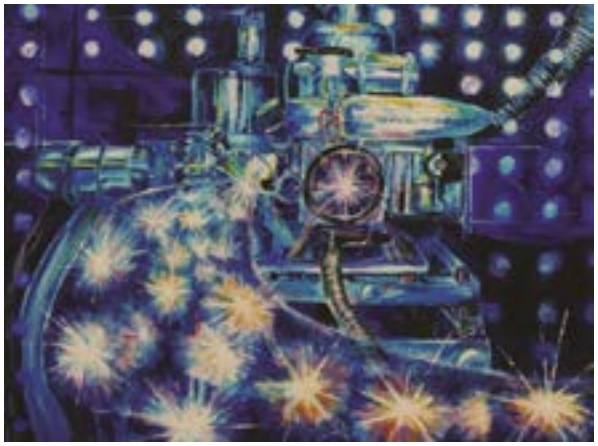
The history and evolution of molecular threshold photoelectron spectroscopy and threshold photoelectron photo-ion coincidence spectroscopy (TPEPICO) in the gas phase over the last fifty years is reviewed. Emphasis is given on instrumentation and the extraction of dynamical information about energy selected ion dissociation, not on the detailed spectroscopy of certain molecules. Three important advances have greatly expanded the power of the technique, and permitted its implementation in modern synchrotron radiation beam lines. (a) The use of velocity focusing of threshold electrons onto an imaging detector in the 1990s simultaneously improved the sensitivity and electron energy resolution, and also facilitated the subtraction of hot electron background in both threshold electron spectroscopy and TPEPICO studies. (b) The development of multi-start multi-stop collection detectors for both electrons and ions in the 2000s permitted the use of the full intensity of modern synchrotron radiation thereby greatly improving the signal-to-noise ratio. (c) Finally, recent developments involving imaging electrons in a range of energies as well as ions onto separate position-sensitive detectors has further improved the collection sensitivity, so that low density samples found in a variety of studies can be investigated. As a result, photoelectron photo ion coincidence spectroscopy is now well positioned to address a range of challenging problems that include the quantitative determination of compositions of isomer mixtures, the detection and spectroscopy of free radicals produced in pyrolysis or discharge sources as well as in combustion studies.



Deity of Science: Award winning original art work by Dr Jonelle Harvey (PhD student of RT). It depicts the imaging PEPICO end-station at the Swiss Light Source (where some of the data described in Paper1 (below) were taken), and the constant stream of information produced from reactions generated from within.

Biography

Richard Tuckett completed his PhD in near-infrared spectroscopy from University of Cambridge in 1979. He first worked in electronic fluorescence spectroscopy of free radicals and molecular cations, often using supersonic beams and non-resonant electron excitation. From the late 1980s, he started using tunable vacuum-ultraviolet photon excitation from a synchrotron as a resonant ionisation source. He also developed an interest in threshold photoelectron spectroscopy and related coincidence techniques, particularly threshold photoelectron photo-ion coincidence studies.

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